Military Applications of Lasers: An Overview

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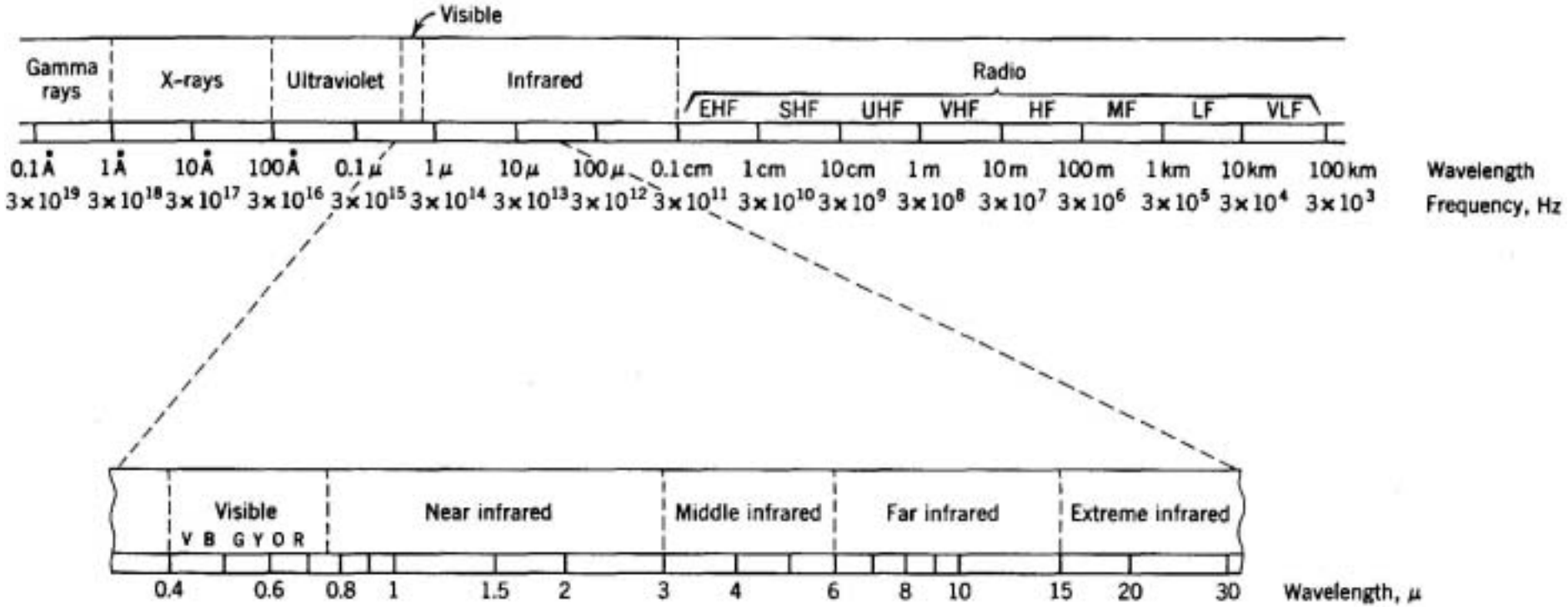
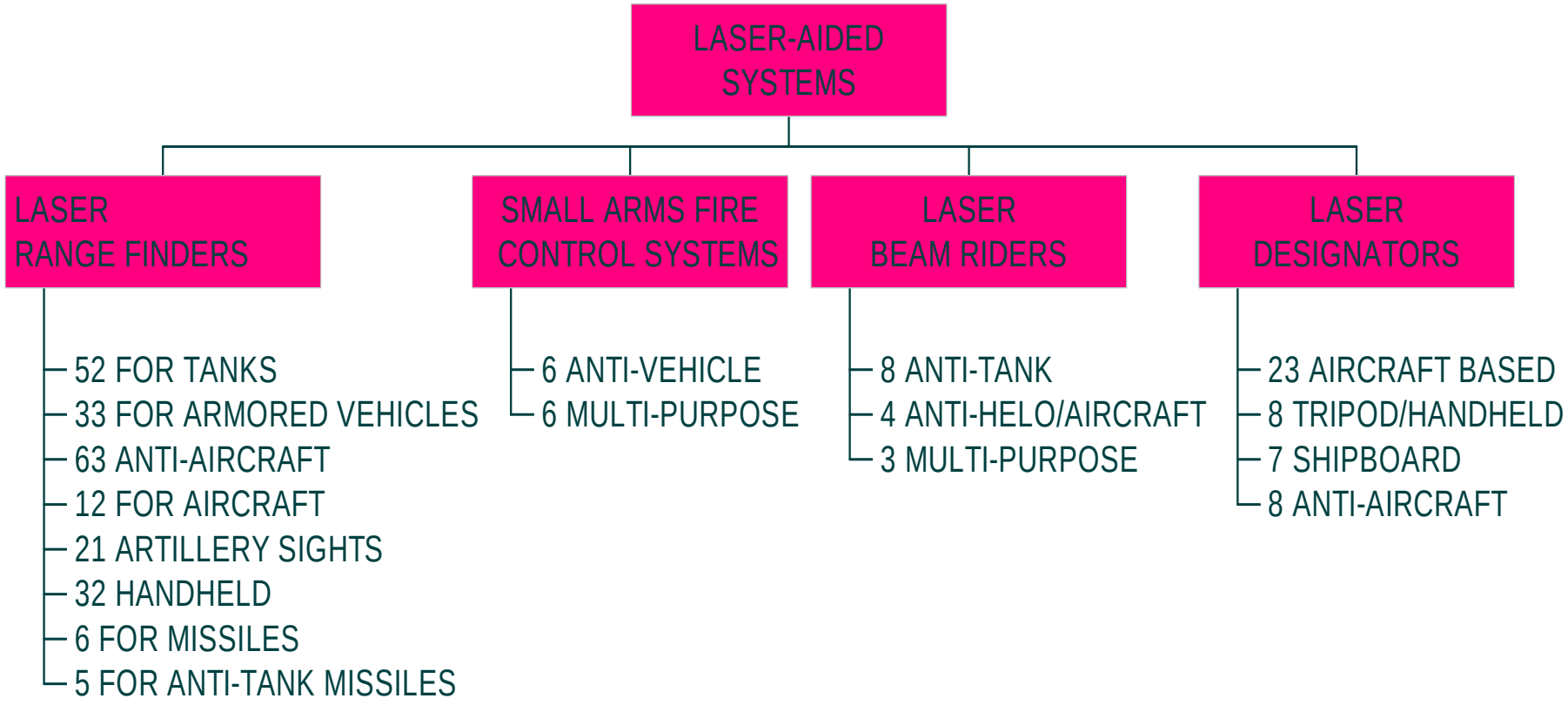
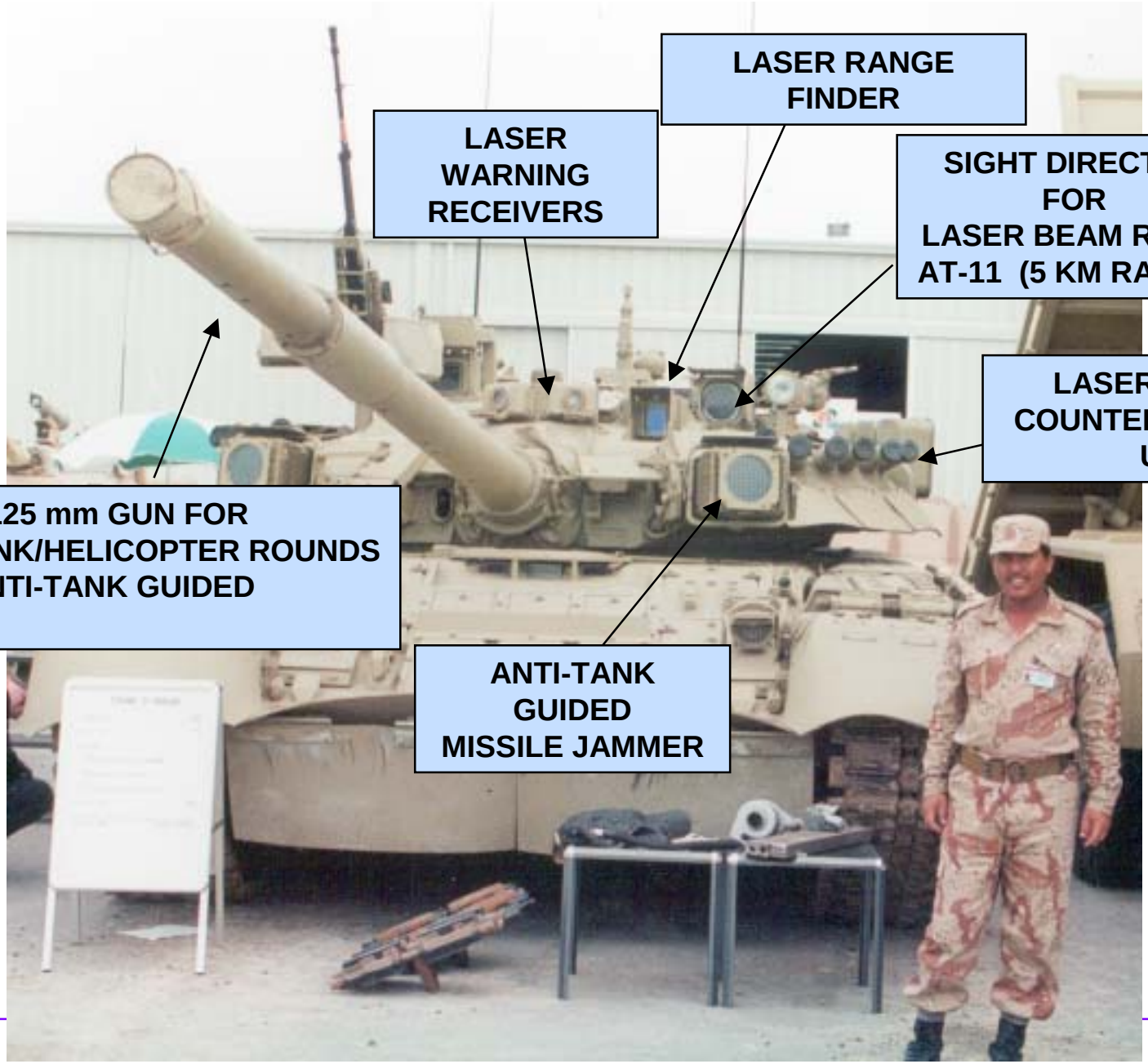
The Optical Spectrum



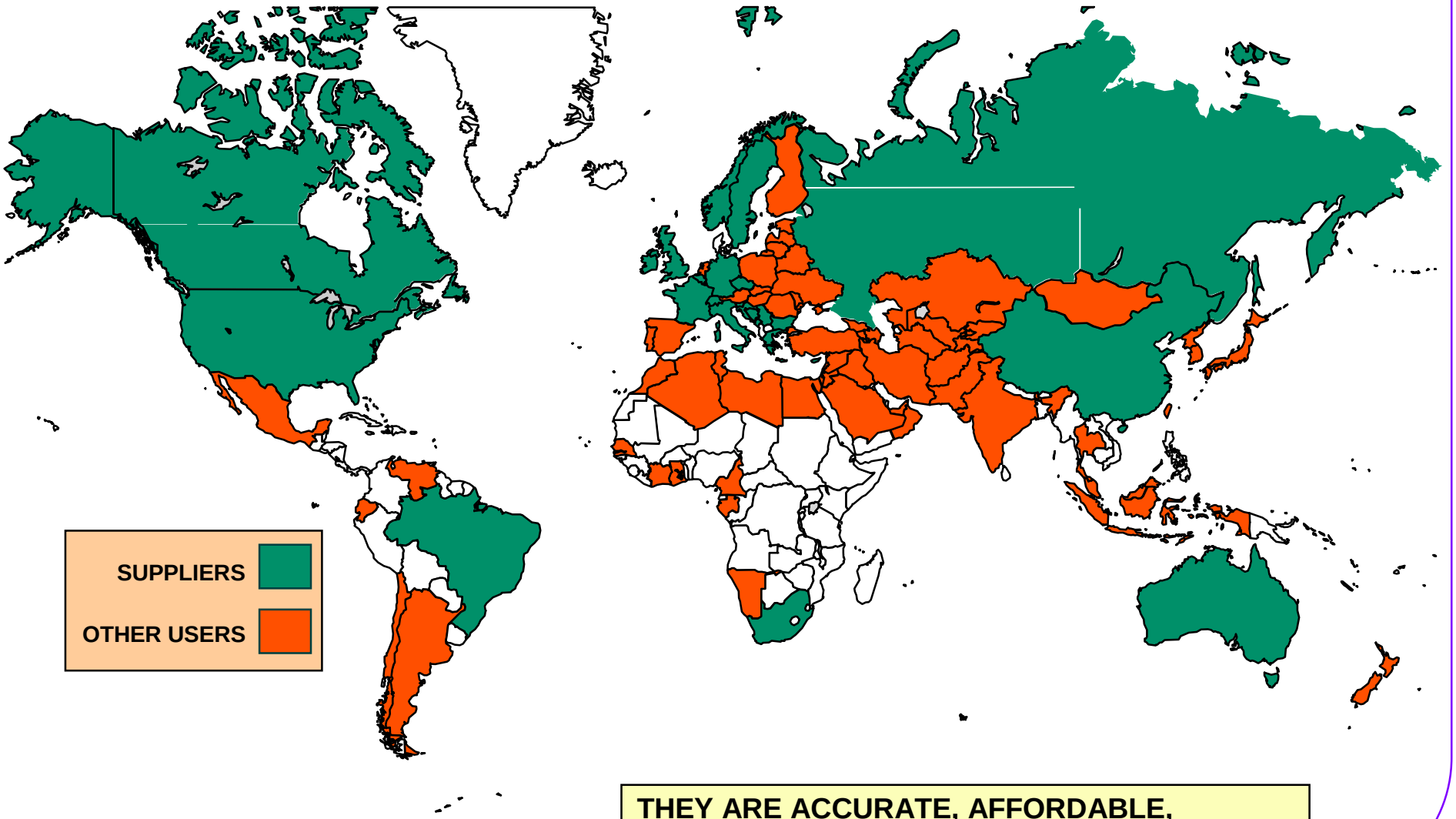
Laser Threats



Modern EO Systems



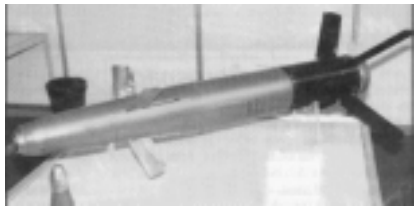
Suppliers and Users



THEY ARE ACCURATE, AFFORDABLE, LETHAL AND AGGRESSIVELY MARKETED.

Recent Additions

- Portable Beam Riders
  - –Many are small and portable
  - –They can be hidden anywhere - bushes, trees, small boats
  - –No radar is needed - no radar warning receiver alert



- Anti-Aircraft Artillery Laser Fire Control Upgrades
  - –Italian VANTH/MB Fire Control System for local control of anti-aircraft field guns
  - –Chinese (NORINCO) laser course director for manual 37 millimeter guns
    - With or without their own servo system
    - Improves firing accuracy 2 to 3 times

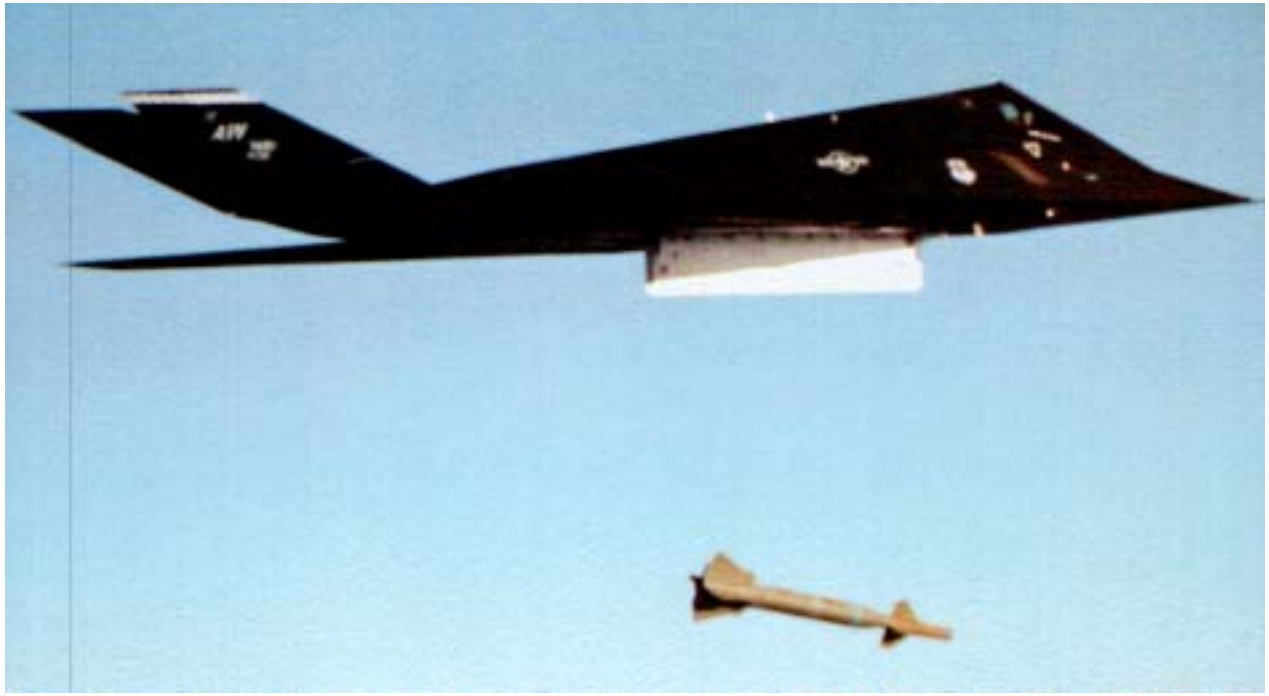
- Laser Designated Artillery Projectiles
  - –Russian Kitolov
    - 122 /120 millimeter versions
    - High explosive warhead
    - Fired by D30, 2S1 howitzers, combo guns
    - 12 kilometer range
  - –Russian Krasnopol
    - 152 millimeter
    - Fired by new 2S19 self-propelled gun, older 2S3M, 2A65 and D-20 towed artillery

Operation Desert Storm

- Laser-guided weapons
  - GBUs
  - HELLFIRE
  - Maverick
  - SLAM
- Laser rangefinders
  - M1 tank
- FLIRs
  - airborne
  - tank

- Precision guided weapons delivery
  - LANTIRN
  - TRAM
  - PAVE TACK
  - TIALD
  - ATLAS
  - TADS/PNVS

Precision Guided Weapons

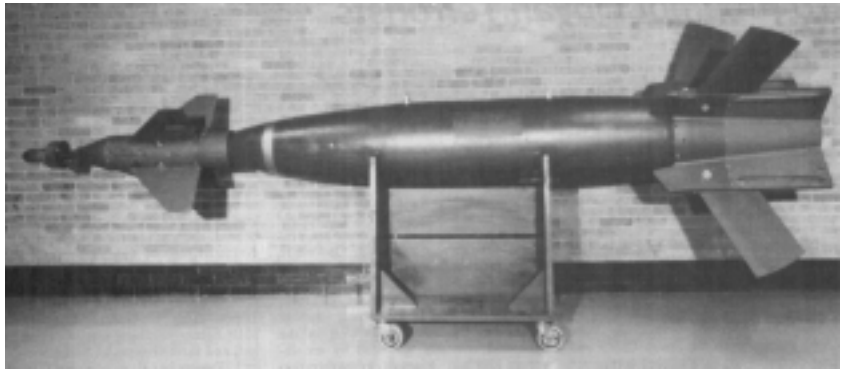


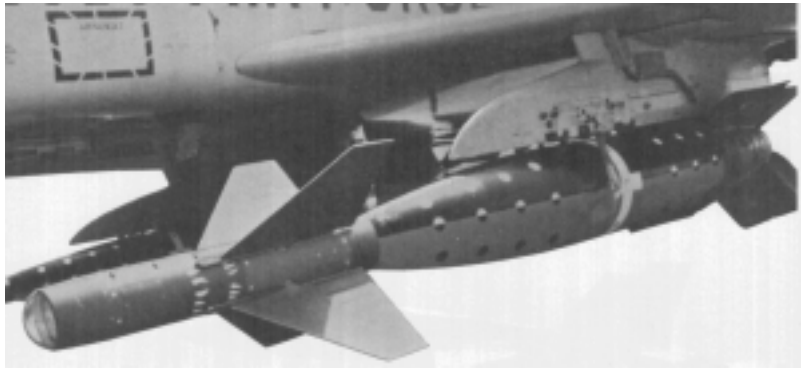
Laser Target Designators

- Application:
  - Precision guidance of munitions to laser spot on target
- Lasers used:
  - Nd:YAG
  - CO2 (R&D)
- Advantages
  - Increased accuracy
  - Integration with thermal imagers and laser spot trackers in weapons delivery system

- Systems
  - GLLD (Army), MULE (USMC), TRAM (USN), LANTIRN (USAF),
- Problems
  - Degraded by obscurants and weather
  - Must maintain beam on target during weapons delivery
- Status:
  - Proven technology
  - Expect proliferation of systems to third world

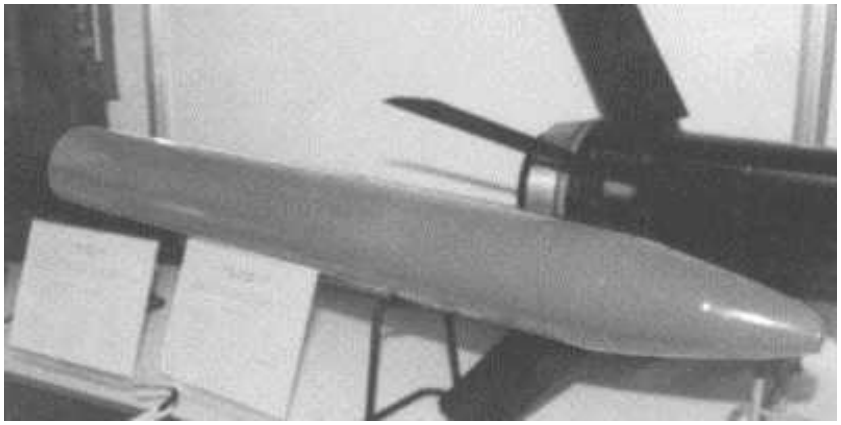
Guided Bombs

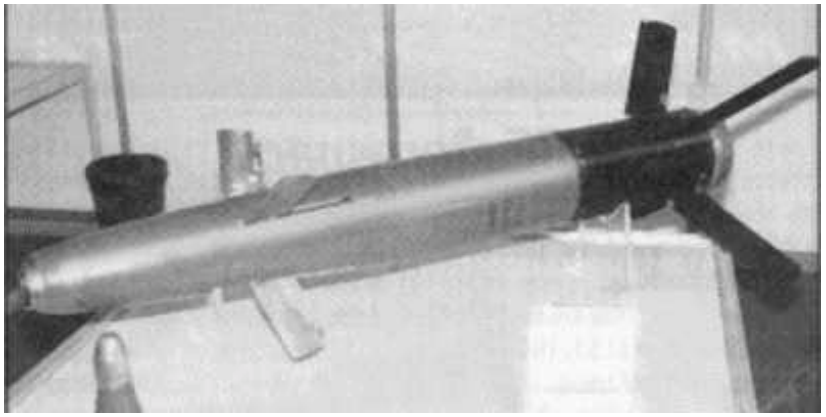




- Left - USAF/Texas Instruments Paveway 2 laser-guided bomb
- Right - Paveway III laser-guided bomb

Guided Artillery





- Russian Kitolov round
- Russian Krasnopol round

Precision Delivery (cont)

- Left - Guided bomb
- Right - AGM-65E Laser Maverick missile

International Systems

- Left - French Mirage 2000 D/S with laser designator pod
- Right - French Matra 1,000 kg bomb dropped from Mirage 2000
  - Available to export customers as option on Mirage 2000

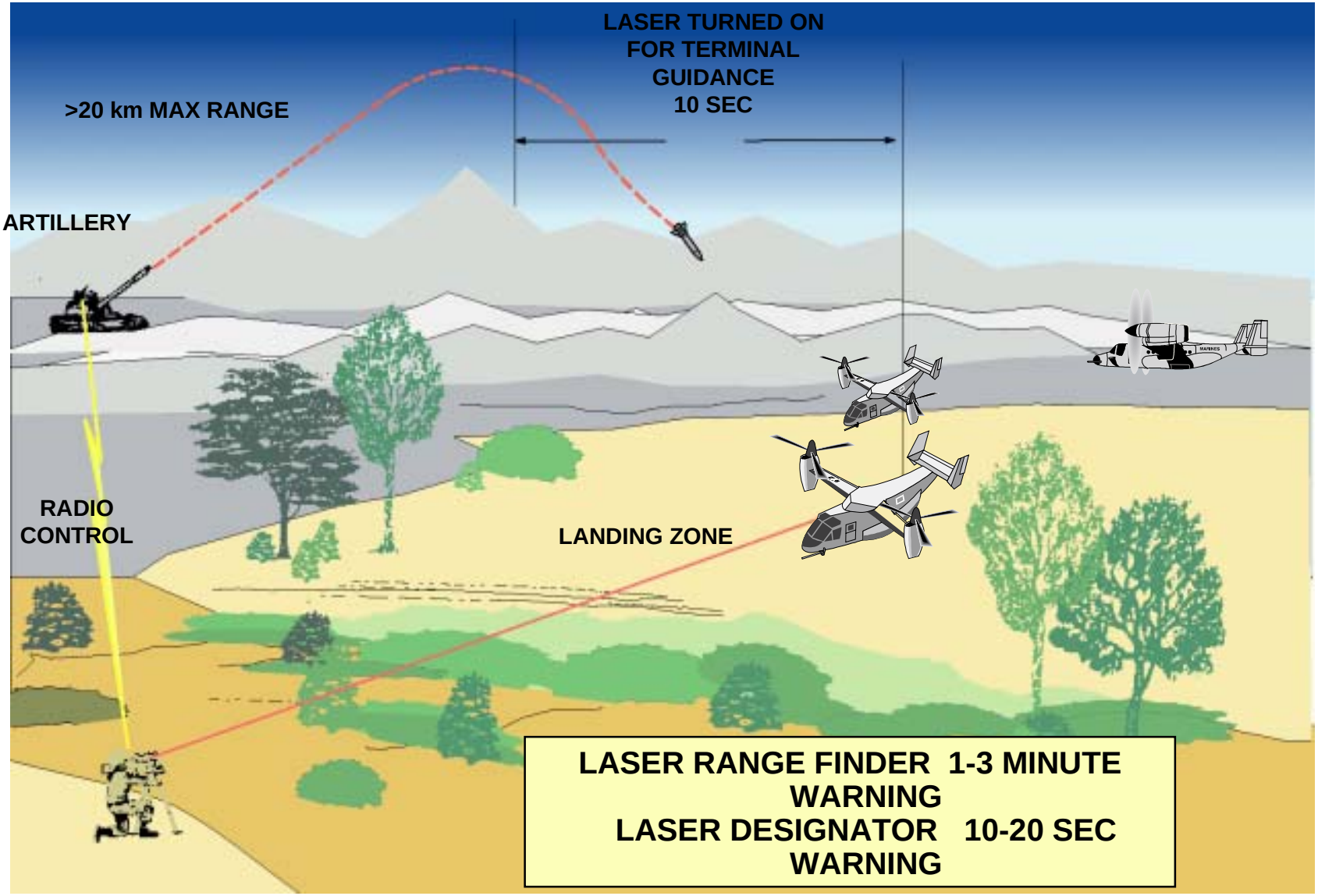
GLLD

- Army GLLD (Ground Locator Laser Designator)

MULE

- Modular Universal Laser Equipment (MULE)

Laser Designator Artillery



Laser Rangefinders

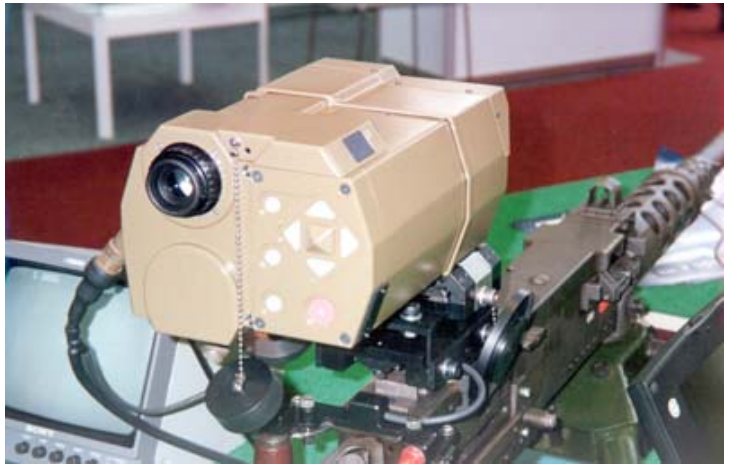
- Application
  - Precision ranging to target for increased fire-control solution accuracy
- Lasers used
  - Ruby (early versions)
  - Nd:YAG
- Advantages
  - Increased accuracy
- Problems
  - Degraded by obscurants

- Status
  - ⇨ Mature technology
  - ⇨ Combined with laser designators
  - ⇨ R&D for eyesafe versions (Er:glass and Raman- shifted)

Some Rangefinder Threats

Russian T80UK

NORINCO AAA Upgrade System



Multipurpose Universal
Gunner Sight (MUGS) 4MK II

BOFORS 40 Millimeter BOFI Gun System

More Threats

ATLAS - Short Range Air Defense System

- E/O Sensor
  - IR
  - TV
  - Eye safe LRF
- Multiple Missile Combinations
  - SA-16
  - RBS-70
  - MISTRAL
  - STINGER

CIS 2S6 Tugunska

- E/O Sensor with LRF
  - Radar
  - Combination
  - Dual 30 mm gun
  - SA-19 missiles

Handheld Rangefinders

- Handheld laser rangefinder
- Laser rangefinder image

Handheld Rangefinders

- Prototype for the laser speedgun

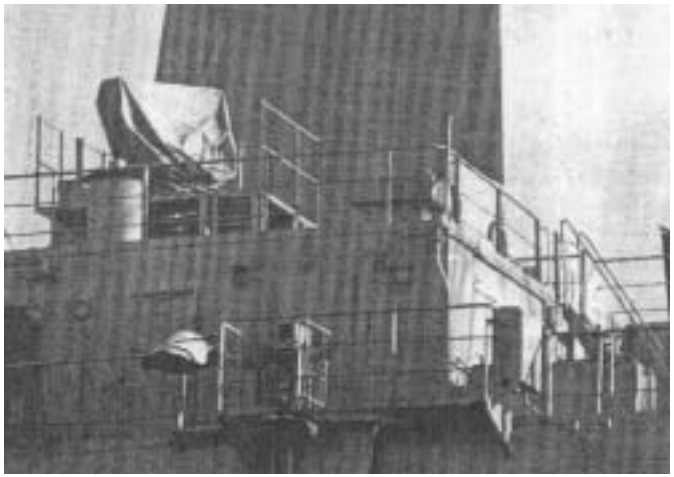
Electro-optic Countermeasures(EOCM)

- Application
  - EO device jammers
  - Illumination warning receivers
- Lasers used
  - Various (Nd, CO2)
- Problems
  - Reliability of jammer lasers
  - Cost of jammer lasers
  - Lack of widespread threat

- Status
  - Low level R&D
  - Not widely deployed
  - increased threat should bring increased development

Laser Dazzling and Blinding

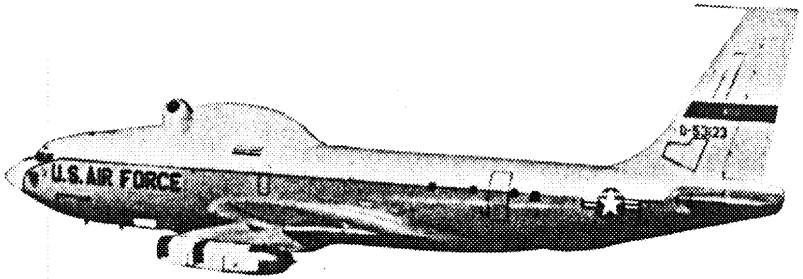
- Application
  - Use of lasers to "dazzle" or blind EO sensors
- Lasers used
  - Nd, CO2, pulsed ruby
- Problems
  - 1995 treaty bans development of “blinding” weapons
  - Contrary to Geneva Convention to injure human vision
  - Cannot blind electronic sensors w/o blinding human observers
- Status: very low R&D



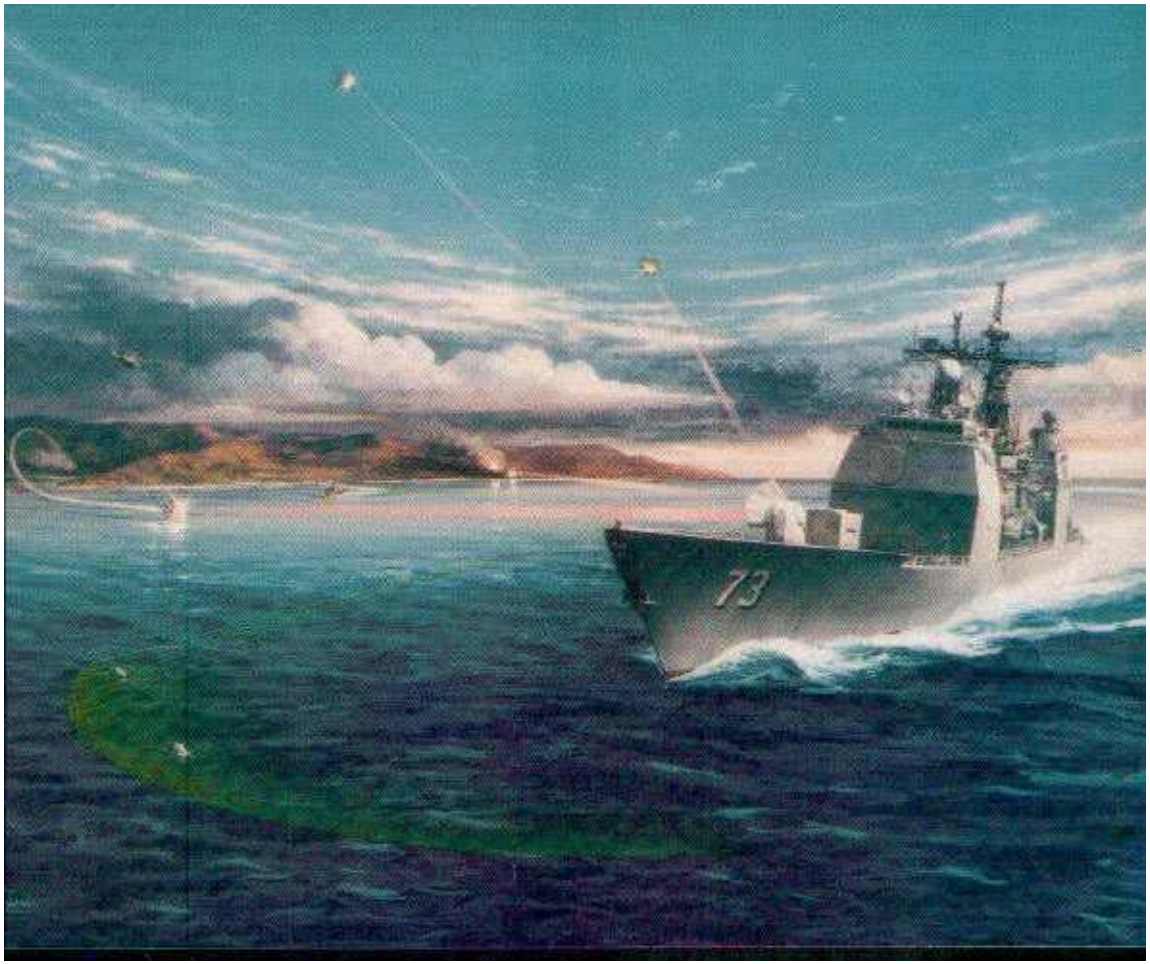
Laser Weapons

- Application
  - Strategic defense
  - Tactical point defense of high-value targets
- Lasers used
  - CO2 gasdynamic lasers
  - Chemical lasers (HF/DF, oxygen iodine)
  - Excimer lasers
  - Free-electron lasers

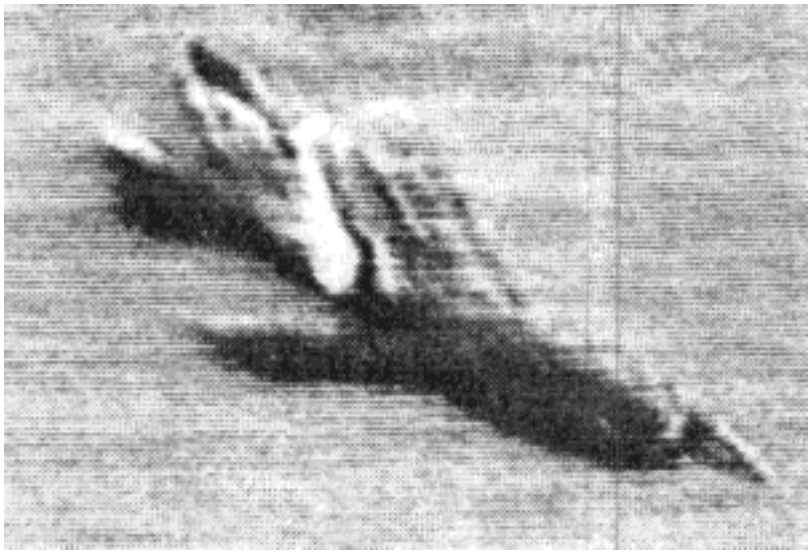
- Problems
  - Laser size and efficiency
  - Prime power generator
  - Atmospheric propagation
  - Pointing and tracking
  - Marginal operational capability
- Status
  - Researched since mid 60s
  - Still long-term R&D

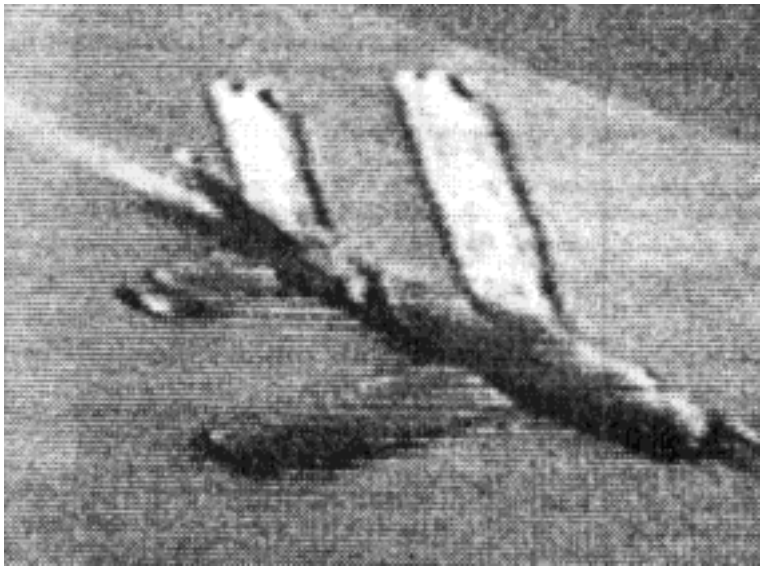


HEL Navy Applications



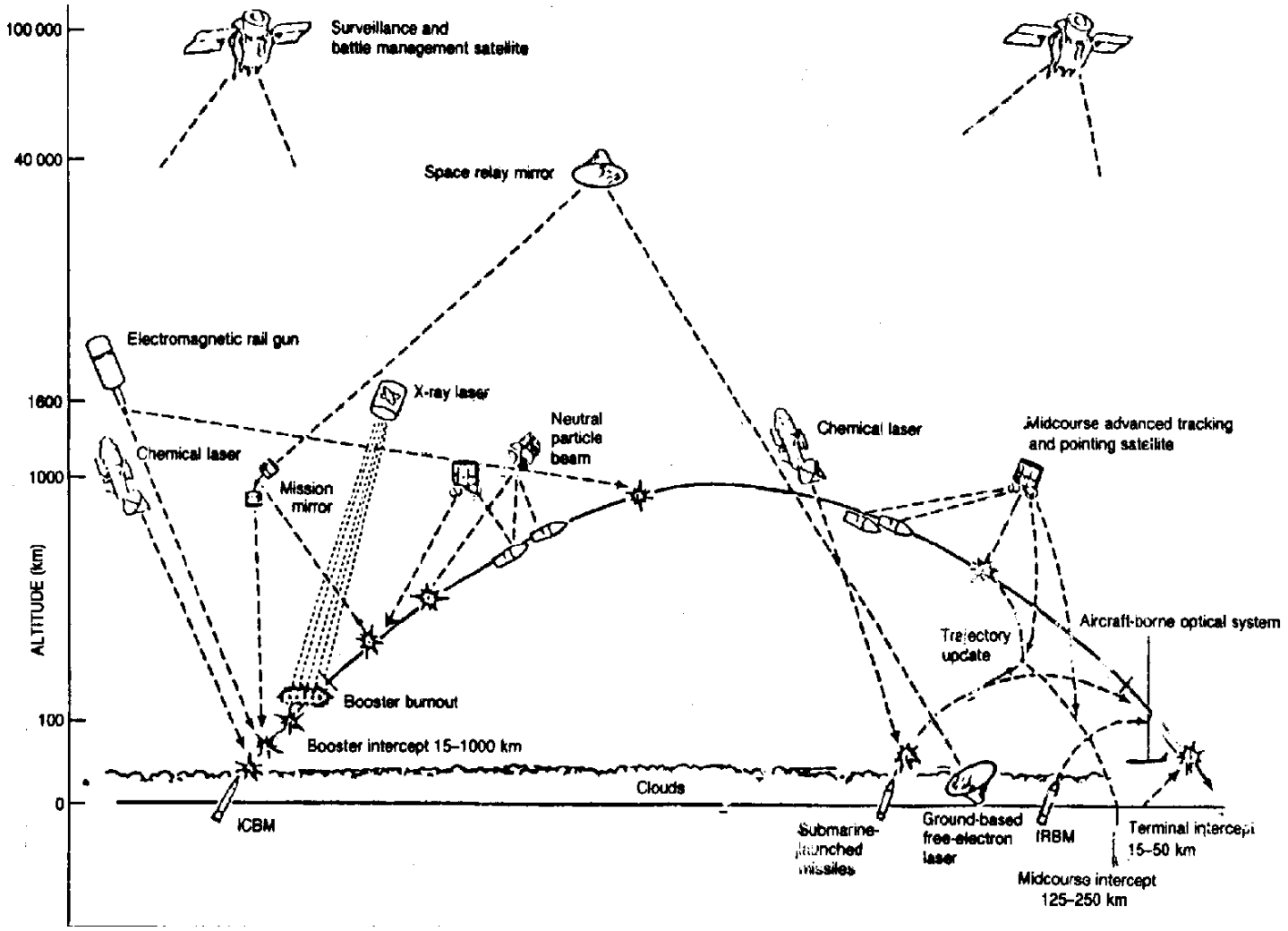
Lethality Demonstration





- Drone

Strategic Defense (SDI)



- Layered defense from ICBM and Theater Missiles

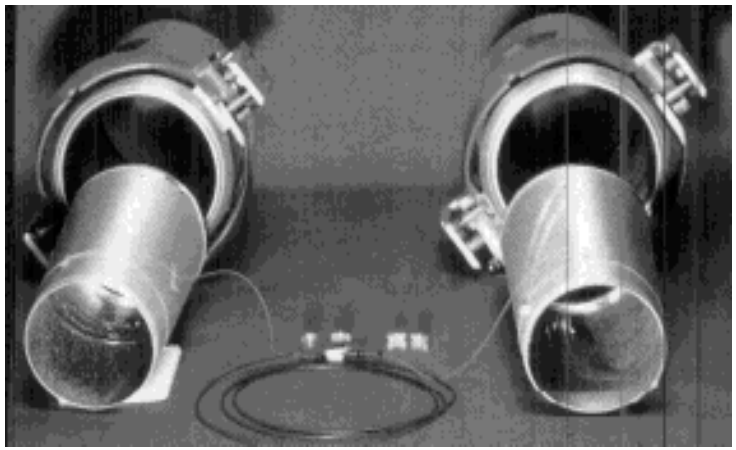
Ground-Based Optical Communications

- Applications
  - High data-rate, LPI communications
- Lasers used
  - CO2 (Navy)
  - Diode lasers (Army, Navy)
  - Diode lasers for fiber optics (all services)
- Problems
  - Lack of broadcast capability (point-to-point only)
  - Range limited to line-of-sight
  - Battlefield and sea obscurants
- Status
  - Demonstration systems

Tethered Remotely-Piloted Vehicles

- Application
  - Control of remote vehicles and missiles by fiber optic links
- Lasers used
  - Diode lasers
- Advantages
  - Antijam capability
  - No radio-location of controlling site
- Status
  - Developmental programs by joint service office (RPVs) and individual services (missiles)

Fiber bobbins



Space/Air to Underwater Communications

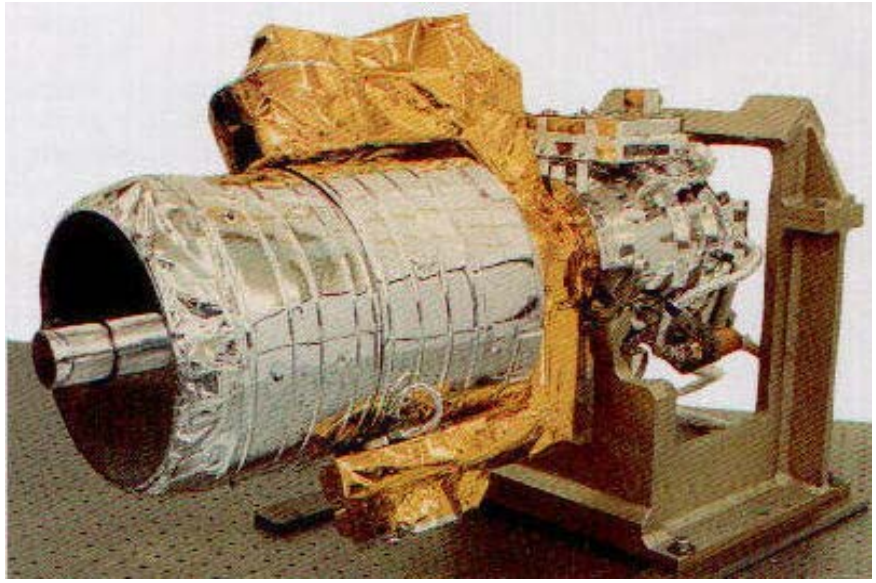
- Application
  - Satellite/aircraft to submarine communications via blue/green laser
  - Moderate data rate
  - One of only two electromagnetic windowsLasers used
  - Frequ□ncy shifted Nd:YAG blue/green lasers
  - Excimer blue lasers (R□man shifted light)

- Problems
  - Flashlamp lifetimes
  - Non-optimum colors
  - Receiver design for signal-to-noise ratio
  - Lead-based frequency shifters
  - Non-cooperative platforms
- Status
  - 15-year-old program
  - DARPA-sponsored
  - Congressional mandate
  - R&D into laser sources (doubled Ti:sapphire, LiAsF)

Space Communications

- Application
  - High data rate, low probability of intercept
  - Satellite-to-satellite data relay
  - Uplinks and downlinks
- Lasers used
  - Frequency-doubled Nd:YAG, CO2
- Problems
  - Space-qualified lasers
  - Laser lifetime (flash tubes, diode pumping)
  - Cost
  - Pointing and tracking difficult

- Status
  - Studied for 15 years, still in R&D
  - New laser sources: diode-pumped lasers



Laser comm for Teledesic satellite array

Laser comm for Teledesic satellite array

Undersea Surveillance

- Application
  - Use of blue-green lasers for shallow-water ASW and minehunting
- Lasers used
  - Frequency-doubled Nd:YAG
  - Pulsed dye
  - Frequency-shifted excimer lasers

- Problems
  - Severe attenuation and back-scatter
  - Depth is function of geographical location
  - Source of illumination is revealed
- Status
  - Studied for 15 years
  - Minehunting being implemented

Biological & Chemical Warfare Agent Detection

- Application
  - Use of tunable laser for remote detection of airborne biological and/ or chemical warfare agents.
- Lasers used
  - Pulsed CO2 (long range)
  - Tuned dye lasers (short-range)
- Problems
  - Lack of lasers at suitable wavelengths
  - Lack of tunability of current powerful lasers (e.g., CO2 can be tune +/- 5%)

- Status
  - Laboratory and field prototype demonstrations
  - Development of more tunable sources.

Ground-Based Laser Radar

- Application
  - Anti-air defense
  - Supplement radars in CM environment
  - Greater accuracy than radar
- Lasers used
  - Nd:YAG, CO2
- Problems
  - Lack of all-weather capability
- Status
  - Army & Navy have built demonstration units

Airborne Doppler Laser Radar

- Application
  - Moving target indicator (MTI) for airborne and surface vehicles
  - High accuracy
  - Useful for wind sensing, target acquisition/ ID/ tracking.
- Lasers used
  - CO2 (frequency stability; heterodyne detection)

- Problems
  - Large size
  - Optical/ electronic complexity
  - Degraded by obscurants.
- Status
  - 15 years of study
  - R&D

Laser Ranging Imaging Systems

- Application:
  - Use a scanning pulsed laser rangefinder to build up high resolution 3-d profile and image
  - Use for target acquisition, id, and tracking
- Advantages
  - High resolution
  - LPI and antijam
- Lasers used:
  - GaAs

- Problems
  - Need more powerful, eye-safe pulsed lasers
- Status
  - R&D into laser sources
  - Demonstration of systems concepts.

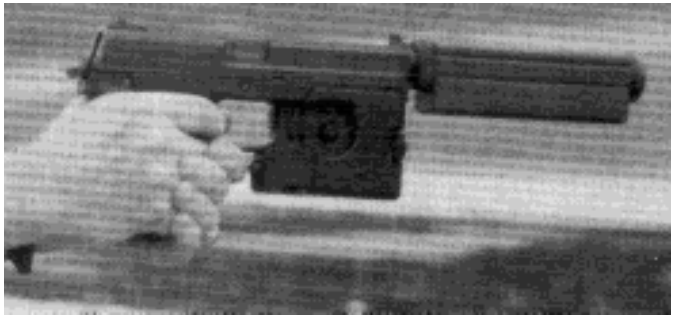
Ordnance Initiation

- Application
  - Fuzing ordnance, use fiber optics to guide laser pulse to detonation point
  - Pulse detection electrically triggers ordnance
- Advantages
  - Immune to EMI and EMP
- Lasers used
  - Pulsed diode lasers
- Status
  - Deployed (e.g., advanced optical fuse/profilometer on TOW-2B)
  - Mature technology
  - Advanced algorithms, discrimination being studied.

IR Aiming Lights

- Application
  - Weapons aiming with night vision goggles
- Advantages
  - Increased weapon aiming precision.
- Problems
  - Degraded by obscurants.
  - Identifies the illuminator.
- Lasers used
  - Pulsed diode lasers bore-sighted with weapon.

- Status
  - Development of GaAs-based devices for night vision systems and CO2 for thermal imaging systems



Laser Weapons Simulators

- Application
  - Simulation of weapons fire for war gaming
- Lasers used
  - HeNe, diode, Nd:YAG
- Deployment
- MILES system widely used at military training sites (Ft. Irwin, Ft. Hood, Ft. Hunter-Liggett)
- Advantages
  - "Free" bullets

- Problems
  - Detector instrumentation of targets
  - Degraded by obscurants
- Status
  - Mature technology.
  - R&D into better obscurant penetration using CO2 and other long wavelengths

Beamrider Systems

RBS-70 Anti-Aircraft Missile System

Short's Starstreak Air Defense Missile System

Starburst Laser Beam Rider Variants

Self-Propelled System

Naval Multiple Launcher

BMP-3

Russian T80UK

Shoulder Launch System

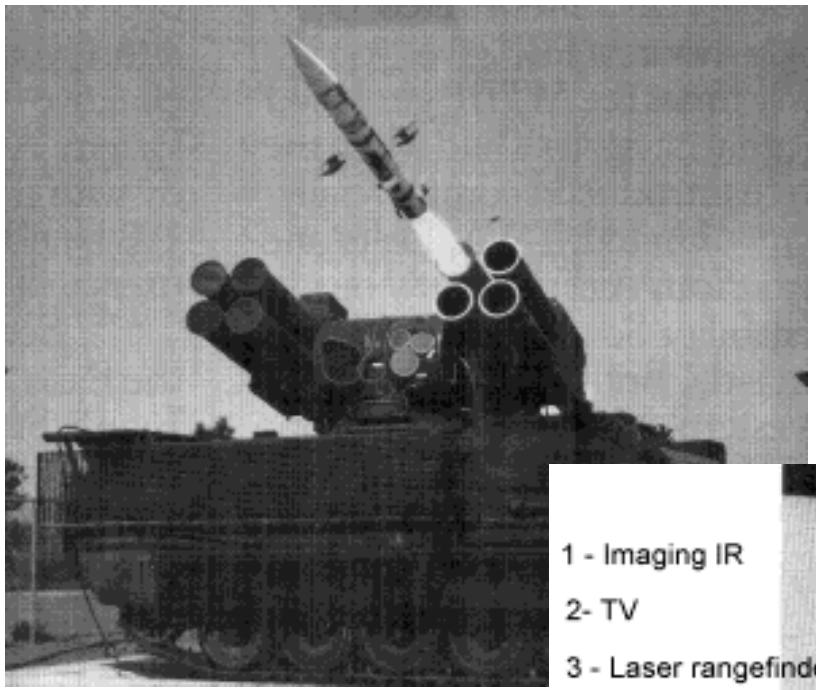
Lightweight Multiple Launcher

Laser Beam-Riding Missiles: RBS-70 and Starstreak

- "Ray-Rider" SAM
- Sweden & export
- 15,000 ft range
- Australian Army (replaces Redeye)

- UK
- Short-range SAM

Laser Beam-Riding Missiles: ADATS

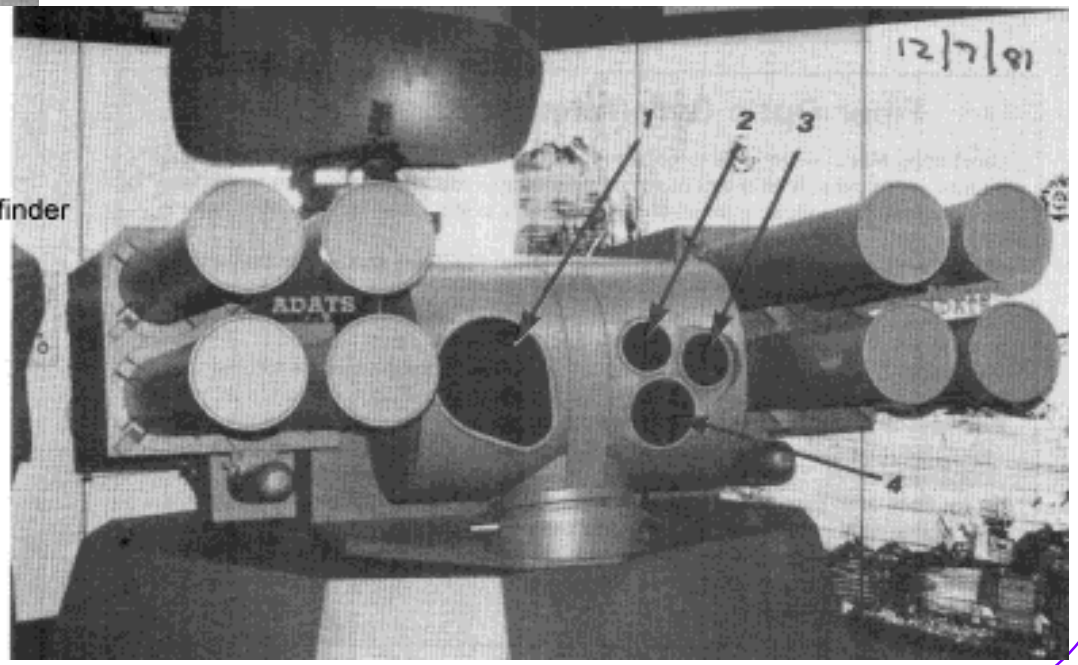


1 - Imaging IR

2- TV

3 - Laser rangefinder

4- Command laser beam



Laser Beam-Riding Missiles

- Application
  - Command guided missile (anti-tank, ground-to-air, air-to-ground) rides laser beam to target
- Advantages
  - Antijam geometry
- Problems
  - Illuminator must track target for entire time-of-flight of missile.
  - Missile cannot be handed off to other controlling location
  - Obscurants present problem (includes missile exhaust)
- Status
  - Several beam-rider systems operational and available for export market

Summary

- Laser technology...
  - is here
  - works
  - opens a new window in the electromagnetic spectrum in warfare